



Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials¹

This standard is issued under the fixed designation E 466; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the procedure for the performance of axial force controlled fatigue tests to obtain the fatigue strength of metallic materials in the fatigue regime where the strains are predominately elastic, both upon initial loading and throughout the test. This practice is limited to the fatigue testing of axial unnotched and notched specimens subjected to a constant amplitude, periodic forcing function in air at room temperature. This practice is not intended for application in axial fatigue tests of components or parts.

NOTE 1—The following documents, although not directly referenced in the text, are considered important enough to be listed in this practice:

E 739 Practice for Statistical Analysis of Linear or Linearized Stress-Life (S-N) and Strain-Life (ϵ -N) Fatigue Data

STP 566 Handbook of Fatigue Testing²

STP 588 Manual on Statistical Planning and Analysis for Fatigue Experiments³

STP 731 Tables for Estimating Median Fatigue Limits⁴

2. Referenced Documents

2.1 ASTM Standards:

E 3 Methods of Preparation of Metallographic Specimens⁵

E 467 Practice for Verification of Constant Amplitude Dynamic Loads on Displacements in an Axial Load Fatigue Testing System⁵

E 468 Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Material⁵

E 739 Practice for Statistical Analysis of Linear or Linearized Stress-Life (S-N) and Strain-Life (ϵ -N) Fatigue Data⁵

E 606 Practice for Strain-Controlled Fatigue Testing⁵

E 1012 Practice for Verification of Specimen Alignment Under Tensile Loading⁵

E 1150 Definitions of Terms Relating to Fatigue⁵

3. Terminology

3.1 Definitions:

3.1.1 The terms used in this practice shall be as defined in Definitions E 1150.

4. Significance and Use

4.1 The axial force fatigue test is used to determine the effect of variations in material, geometry, surface condition, stress, and so forth, on the fatigue resistance of metallic materials subjected to direct stress for relatively large numbers of cycles. The results may also be used as a guide for the selection of metallic materials for service under conditions of repeated direct stress.

4.2 In order to verify that such basic fatigue data generated using this practice is comparable, reproducible, and correlated among laboratories, it may be advantageous to conduct a round-robin-type test program from a statistician's point of view. To do so would require the control or balance of what are often deemed nuisance variables; for example, hardness, cleanliness, grain size, composition, directionality, surface residual stress, surface finish, and so forth. Thus, when embarking on a program of this nature it is essential to define and maintain consistency a priori, as many variables as reasonably possible, with as much economy as prudent. All material variables, testing information, and procedures used should be reported so that correlation and reproducibility of results may be attempted in a fashion that is considered reasonably good current test practice.

4.3 The results of the axial force fatigue test are suitable for application to design only when the specimen test conditions realistically simulate service conditions or some methodology of accounting for service conditions is available and clearly defined.

5. Specimen Design

5.1 The type of specimen used will depend on the objective of the test program, the type of equipment, the equipment capacity, and the form in which the material is available. However, the design should meet certain general criteria outlined below:

5.1.1 The design of the specimen should be such that failure occurs in the test section (reduced area as shown in Fig. 1 and Fig. 2). The acceptable ratio of the areas (test section to grip

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² *Handbook of Fatigue Testing*, ASTM STP 566, ASTM, 1974.

³ Little, R. E., *Manual on Statistical Planning and Analysis*, ASTM STP 588, ASTM, 1975.

⁴ Little, R. E., *Tables for Estimating Median Fatigue Limits*, ASTM STP 731, ASTM, 1981.

⁵ *Annual Book of ASTM Standards*, Vol 03.01.

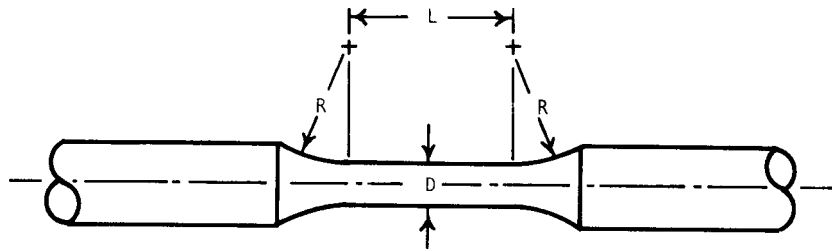


FIG. 1 Specimens with Tangentially Blending Fillets Between the Test Section and the Ends

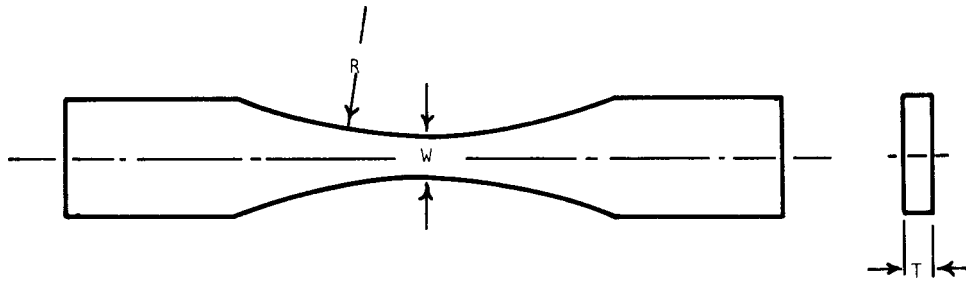


FIG. 2 Specimens with Continuous Radius Between Ends

section) to ensure a test section failure is dependent on the specimen gripping method. Threaded end specimens may prove difficult to align and failure often initiates at these stress concentrations when testing in the life regime of interest in this practice. A caveat is given regarding the gage section with sharp edges (that is, square or rectangular cross section) since these are inherent weaknesses because the slip of the grains at sharp edges is not confined by neighboring grains on two sides. Because of this, a circular cross section may be preferred if material form lends itself to this configuration. The size of the gripped end relative to the gage section, and the blend radius from gage section into the grip section, may cause premature failure particularly if fretting occurs in the grip section or if the radius is too small. Readers are referred to Ref (1) should this occur.

5.1.2 For the purpose of calculating the force to be applied to obtain the required stress, the dimensions from which the area is calculated should be measured to the nearest 0.001 in. (0.03 mm) for dimensions equal to or greater than 0.200 in. (5.08 mm) and to the nearest 0.0005 in. (0.013 mm) for dimensions less than 0.200 in. (5.08 mm). Surfaces intended to be parallel and straight should be in a manner consistent with 8.2.

NOTE 2—Measurements of dimensions presume smooth surface finishes for the specimens. In the case of surfaces that are not smooth, due to the fact that some surface treatment or condition is being studied, the dimensions should be measured as above and the average, maximum, and minimum values reported.

5.2 Specimen Dimensions:

5.2.1 Circular Cross Sections—Specimens with circular cross sections may be either of two types:

5.2.1.1 Specimens with tangentially blended fillets between the test section and the ends (Fig. 1). The diameter of the test section should preferably be between 0.200 in. (5.08 mm) and 1.000 in. (25.4 mm). To ensure test section failure, the grip cross-sectional area should be at least 1.5 times but, preferably for most materials and specimens, at least four times the test section area. The blending fillet radius should be at least eight times the test section diameter to minimize the theoretical stress concentration factor, K_t , of the specimen. The test section length should be approximately two to three times the test section diameter. For tests run in compression, the length of the test section should be approximately two times the test section diameter to minimize buckling.

5.2.1.2 Specimens with a continuous radius between ends (Fig. 3). The radius of curvature should be no less than eight times the minimum diameter of the test section to minimize K_t . The reduced section length should be greater than three times the minimum test section diameter. Otherwise, the same dimensional relationships should apply, as in the case of the specimens described in 5.2.1.1.

5.2.2 Rectangular Cross Sections—Specimens with rectangular cross sections may be made from sheet or plate material and may have a reduced test cross section along one dimension, generally the width, or they may be made from material

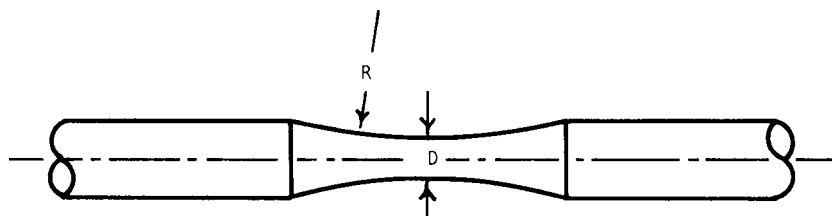


FIG. 3 Specimens with a Continuous Radius Between Ends